Application of the wind atlas for Egypt

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Application of the Wind Atlas for Egypt

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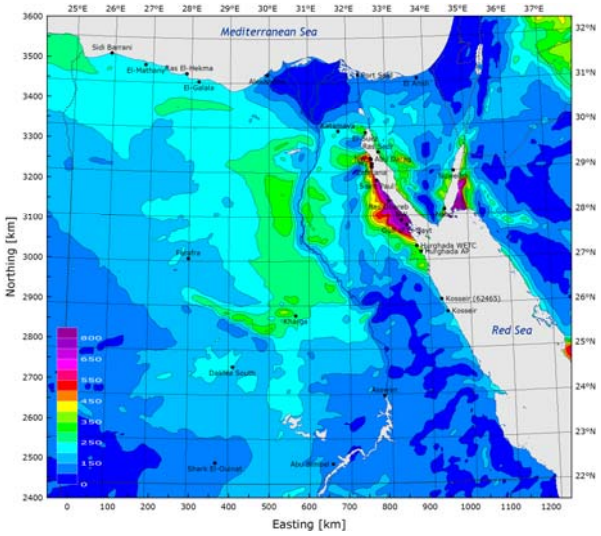
Wind resource assessment and siting

- Application 1: Overview of Egyptian wind resources
  - Input: numerical wind atlas database
  - Output: Maps, statistics, …
- Application 2: Numerical wind atlas + WAsP
  - Input: numerical wind atlas database
  - Output: WAsP results (wind climates, power productions,…)
- Application 3: Observational wind atlas + WAsP
  - Input: observational wind atlas
  - Output: WAsP results (wind climates, power productions,…)
- Topographical inputs
- Summary
- The future…

1. Overview of Egyptian wind resources



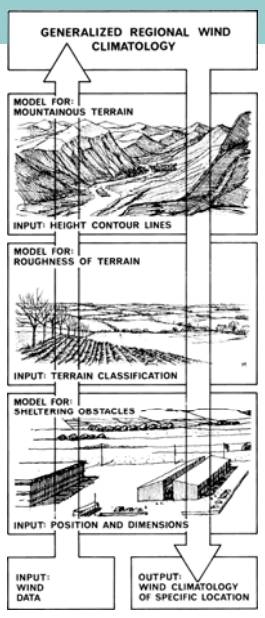
- KAMM modelling
- Resolution 7.5 km
- Map shows PWC
- Wind climate over actual terrain surface
- Mean power density 50 m a.g.l. [Wm^{-2}]
- Linear PD scale

- Output format:
  - map graphic
  - statistics
  - …

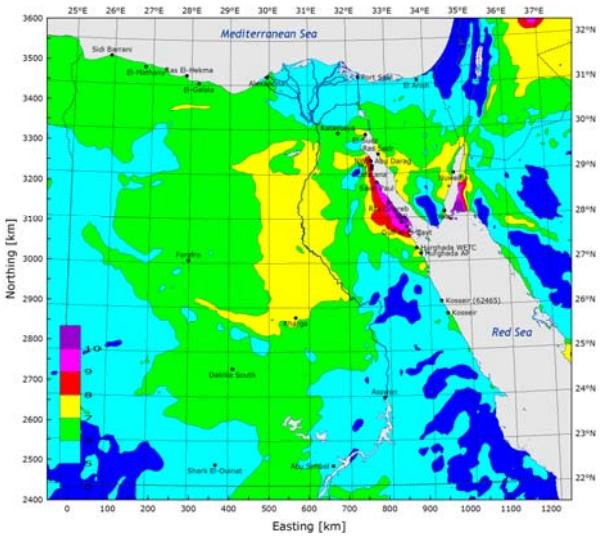
2. Numerical wind atlas

- Analysis procedure (KAMM)
  NCEP/NCAR reanalysis data
  + roughness map
  + elevation map
  ⇒ **Regional Wind Climate**

- Application procedure (WAsP)
  Regional Wind Climate
  + sheltering obstacles
  + roughness map
  + elevation map
  ⇒ **Predicted Wind Climate**
  + power and thrust curves
  ⇒ **Predicted wind farm AEP**



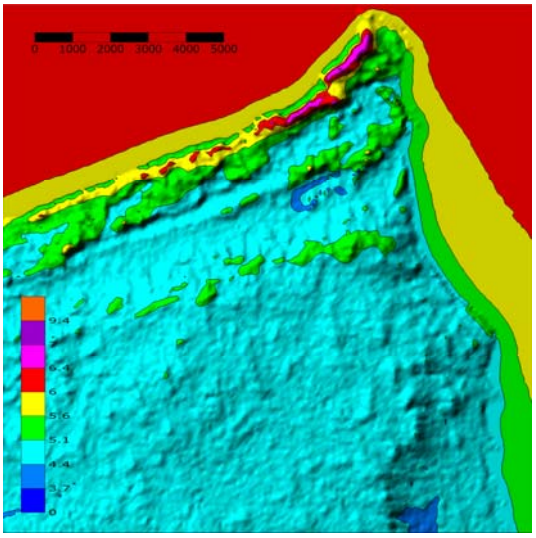
Regional wind climate



- KAMM modelling
- Resolution 7.5 km
- Map shows RWC
- Wind climate over flat, uniform terrain
- Mean wind speed 50 m a.g.l. [ms^{-1}]
- Linear speed scale

- Output format: WAsP *.lib file
  - Weibull *A* and *k*
  - Standard heights
  - Standard z_0

Detailed wind resources at Ras El-Hekma

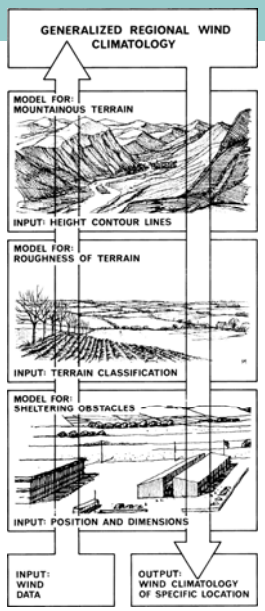


- WAsP modelling of detailed wind speed @ 10 m a.g.l.
- Resolution 100 m
- KAMM wind map indicates Class 2
- Offshore resource is higher: Class 5
- Coastal resource is higher: Class 3/4
- Hill/ridge resource is higher: Class 6

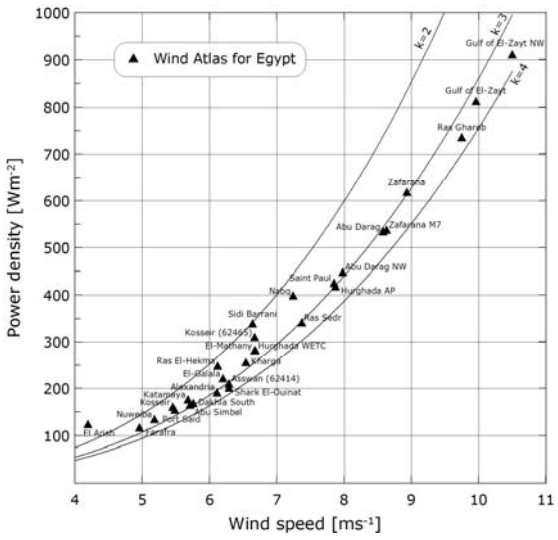
3. Observational wind atlas

- Analysis procedure (WAsP)
  Observed Wind Climate
  + sheltering obstacles
  + roughness map
  + elevation map
  ⇒ **Regional Wind Climate**

- Application procedure (WAsP)
  Regional Wind Climate
  + sheltering obstacles
  + roughness map
  + elevation map
  ⇒ **Predicted Wind Climate**
  + power and thrust curves
  ⇒ **Predicted wind farm AEP**



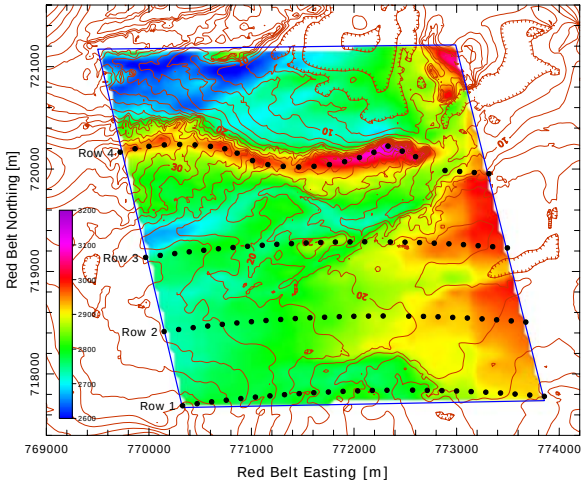
Egyptian regional wind climates



- WAsP modelling
- 30 met. stations
- Graph shows RWC
- Wind climate over flat, uniform terrain
- Mean wind speed and power density 50 m a.g.l.

- Output format: WAsP *.lib file
  - Weibull *A* and *k*
  - Standard heights
  - Standard z_0

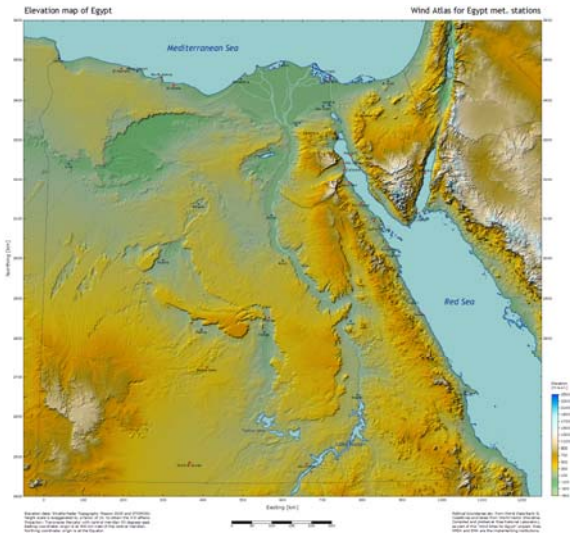
Detailed wind resources at Zafarana

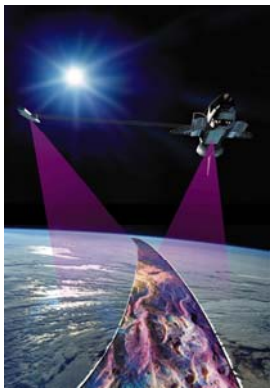


Topographical inputs for WAsP

- Elevation map
  - Shuttle Radar Topography Mission elevation data
  - Digitised topographical map
- Roughness (land-use) map
  - SRTM Water Body Data
  - Satellite imagery
  - Digitised topographical map
  - Aerial photography
- Obstacle description
  - Site visit

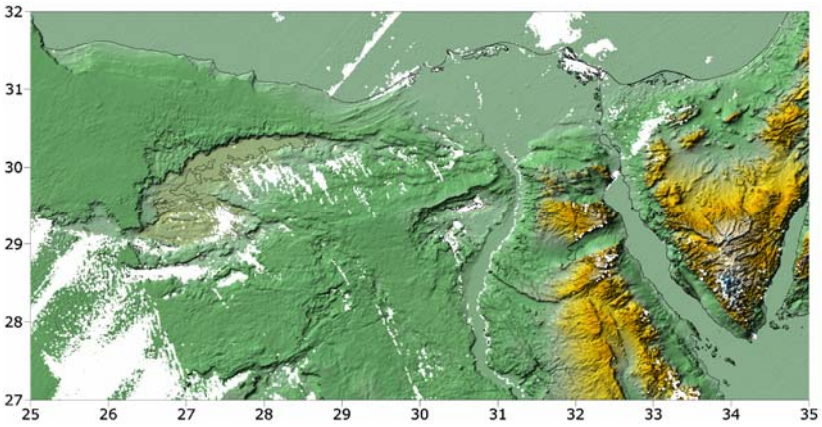
Shuttle Radar Topography Mission





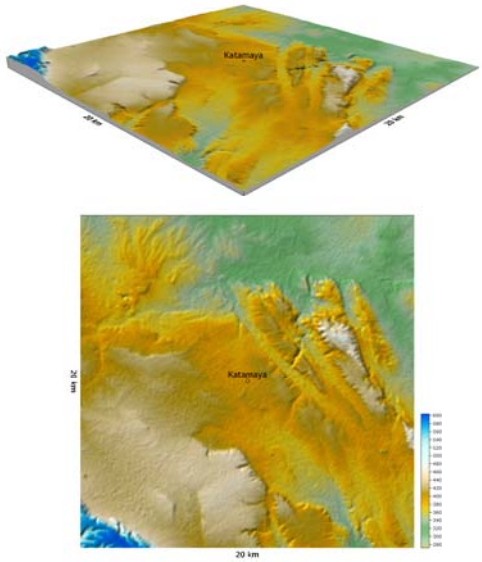
- Grid point elevations
- 3'' (~90 m) resolution
- Vertical accuracy 5-10 m

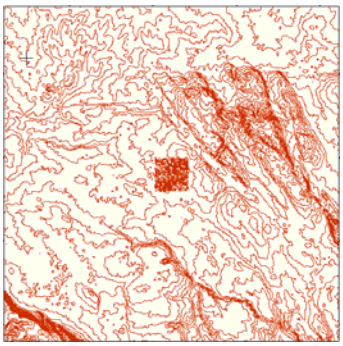
Inspection of raw SRTM data



- Check for missing information (voids = white)
- Check for spikes and wells

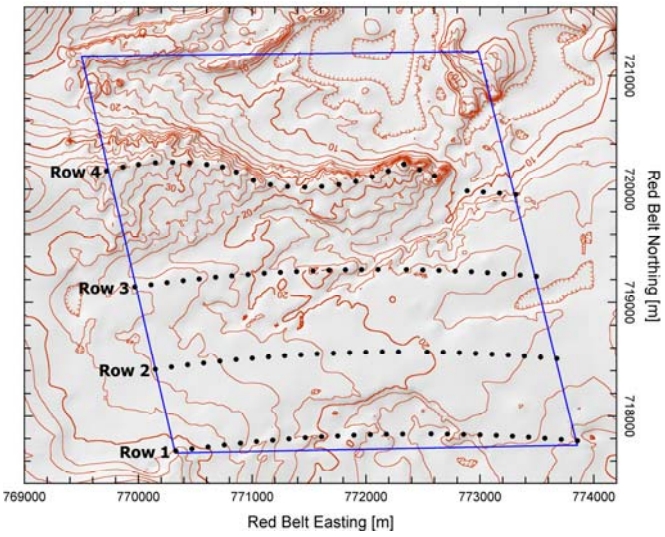
Katamaya elevation map from SRTM data



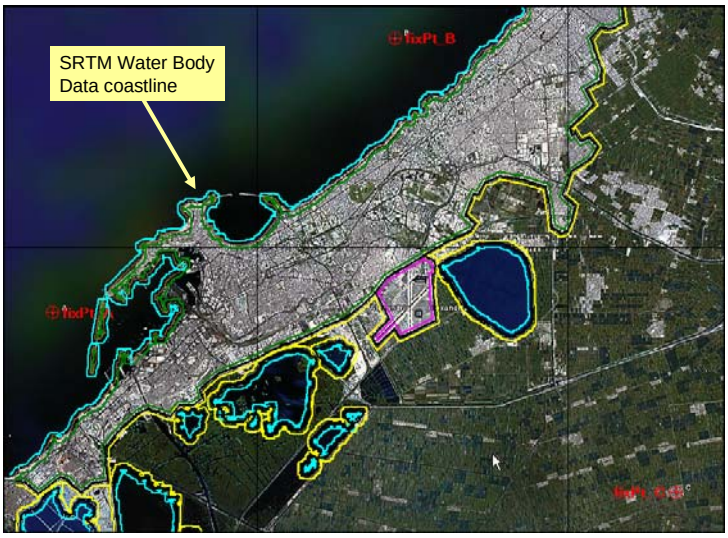


20×20 km with 10-m contours
2×2 km with 1-m contours

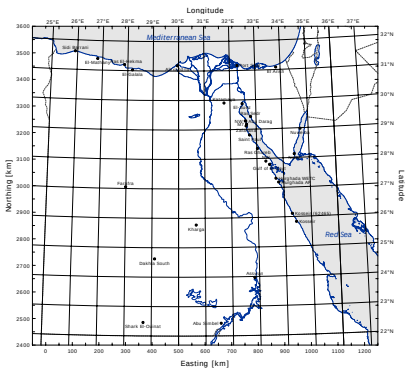
Zafarana elevation map from surveying



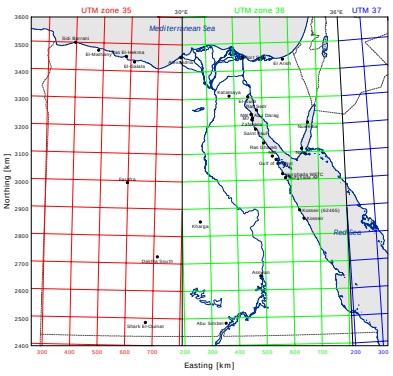
Alexandria roughness map from Google Earth



Coordinate systems



- Geographical latitude/longitude
- World Geodetic System 1984



- Universal Transverse Mercator
- World Geodetic System 1984
- UTM zones 35, 36, 37

Summary – a complete package

- Wind-climatological inputs
  - Numerical wind atlas (all over Egypt)
  - Observational wind atlas (30+ stations)
- Topographical inputs
  - SRTM elevation data (free Internet download)
  - SRTM Water Body Data (free Internet download)
  - Google Earth satellite imagery (free & licensed versions)
- Software tools
  - WAsP, Map Editor, Utility Programs
  - Surfer, Grapher, Didger
- Other resources
  - Wind atlases, wind farm planning report, training, …

The future…

- Numerical wind atlas
  - Long-term data (1968-95) – infrequent updating ok
- Observational wind atlas
  - Some reference met. stations should continue
  - New measurement programmes may be initiated
  - Cup anemometers must be rehabilitated and recalibrated
  - Databases can be updated and extended
  - Wind Atlas for Egypt can be updated

Conclusion: the present approach to wind ressource assessment and siting may be continued for several years.

– I wish you all the best for your future work!